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United States Steel Corporation

Standard Requirements

FOR

SAFETY

PREPARED BY THE

Committee of Safety

SEPTEMBER, 1912

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Standard Requirements

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The information presented in this book has been prepared under the direction of the Committee of Safety of the United States Steel Corporation as a result of the experience of the subsidiary companies and this Committee in preventing injuries to employes. It is to be used as a guide in standardizing the safety appliances and precautions necessary to protect employes from the dangers incident to machinery and working conditions. It aims to insure the provision of efficient safeguards and proper working conditions at the time construction work is planned and machinery is installed.

It is also intended that the present operations and equipment be made to conform to these suggestions so far as practicable when replacement and repairs are made.

Suggestions for additions to and improvements in safety devices and working conditions are invited.

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MEMBERS SAFETY COMMITTEE.

CHARLES MACVEAGH, Chairman, General Solicitor United States Steel Corporation and Subsidiary Companies.

L. H. BURNETT, Assistant to President, Carnegie Steel Co.

JOHN L. CHISOLM, Manager Casualty and Safety Department, Tennessee Coal, Iron & R. R. Co.

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R. J. YOUNG, Manager Safety and Relief Department, Illinois Steel Co.

C. L. CLOSE, Secretary, Manager Bureau of Safety, Relief, Sanitation and Welfare, United States Steel Corporation.

The United States Steel Corporation expects its subsidiary companies to make every effort practicable to prevent injury to employes. Much can be done by designing new construction and machinery with all practicable safeguards.

Expenditures necessary for such purposes will be authorized. Nothing which will add to the protection of the workmen should be neglected.

The safety and welfare of the workmen is of the greatest concern.

E. H. GARY, Chairman.

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RULES AND REGULATIONS.

SECTION 1.

GENERAL.

In the construction of buildings and designing and placing of machinery the safety of the workmen is equally as important as the production of the machine and economy of its operation.

In placing machinery leave ample clearance and provide suitable passageways for traffic and escape.

All persons having anything whatever to do with the making or designing of machinery or the repairing of same should see that the rules herein contained are followed and all other proper safety devices are provided.

All requisitions on Purchasing Department for machinery shall specify that safety devices have been provided.

All drawings or blue-prints should be checked for safety before leaving the drafting room, and so noted by initials of person checking in space provided in title of drawing.

SECTION 2.

BELTS AND PULLEYS

(a) **Location.**—Belts and pulleys shall be so located, wherever possible, as not to be dan-

gerous to employes, or shall be properly enclosed, fenced or otherwise guarded.

(b) **Pipe Railing Guard.**—Bare pipe railing, used as a belt guard, is to be used only where the location of the belt is isolated—where there is but little traffic and the probability of catching material in the belt is remote.

(c) **Wire Netting Guard.**—Wire netting shall be made of wire not less than No. 12 gauge, and not more than 1½-inch mesh.

(d) **Steel Casings.**—Steel casings shall be made of not less than 14-gauge plate, but 10-gauge is recommended.

(e) **Placing of Pulleys on Line Shafting.**—Pulleys on line shafting shall be so placed as to allow the width of the belt between the pulley and the shaft hanger, to prevent the belt becoming wedged, should it slip off the pulley.

SECTION 3.

BESSEMER DEPARTMENT.

PIG IRON YARD.

(a) All workmen in pig iron yard should wear hand leathers of approved design.

(b) Suitable provisions shall be made to protect men from flying pieces of pig iron when cars are being unloaded.

(c) There should be division walls in piles of pig iron, to prevent iron from tangling and

making dangerous piles; also to protect stokers from flying pieces of pig iron when car is being unloaded in other bins.

(d) Metal barrow beds should be made large enough to hold the load safely, to prevent the danger of pigs falling off.

IRON CUPOLAS.

(e) Cupolas shall be covered at charging floor when liners are working in cupolas, to prevent chargers throwing material into cupola or brick falling from stacks on men. These covers should be made of heavy wire screen or net, to allow ventilation to men working cupolas.

(f) Section of cupola just below charging floor shall be made of cast steel, so that it will not warp and allow scrap and other material to fall through between cupola and charging floor.

(g) Drop chutes shall be enclosed as nearly as possible, a 4-inch hole being ample to place bar for knocking out props. Where practicable the props should be pulled by means of snatch block, cable or locomotive, rather than by hand.

(h) When cupola cinder is run in runner through floor this hole should be provided with a shield of sufficient height to prevent workmen from stepping in.

(i) In the Cupola Building, on the dumping floor, protection shall be provided for the men dumping the cupola.

(j) All ladles shall be bottom heavy, and so constructed that when locks are out of place ladle will not upset.

(k) All mixers shall be counterbalanced, so that if pressure is off tipping cylinder the mixer will return to an upright position of its own accord. Next to the operating valve on pressure pipe to front of tipping cylinder shall be placed a cut-off valve which will cut off the pressure from cylinder and open it to the discharge, so that counterweights may bring mixer to its upright position, and not be held by water in cylinder. This valve is to be used only in case of emergency.

(l) Hydraulic cylinder under mixer shall be protected by steel plate, covered with fire brick.

(m) A warning bell shall be installed, to be rung by pourer before pouring a heat.

(n) A safe measure of escape shall be provided for men working on mixer platform.

(o) It is recommended that in place of using a short chain on auxiliary for dumping ladle, a cable fitted with ring and hook be used for this purpose, as links of chain sometimes

twist, giving ladle a sudden jerk which is liable to cause a spill.

(p) Auxiliary hoist of ladle crane shall be equipped with a hook which can be attached by the craneman, to tip ladle after the ladle has been hoisted to the pouring position.

(q) Where knuckle jointed arm is used for dumping iron ladle it shall be covered with leather or other material as a guard against protruding bolts and nuts.

(r) Where plunger elevators are used for hoisting metal to mixer elevation the hoist shall be equipped with safety dogs.

(s) Where plunger elevator is used to convey iron to mixer the opening in the floor caused by raising the hoist shall be protected.

(t) All cages on hot metal cranes shall be arranged so as to give ample protection to cranemen in case of spilling or dropping of a ladle of hot metal. Each crane shall have a sheet iron closet lined with asbestos to be used by cranemen in case anything goes wrong with machinery when hoisting hot metal.

(u) Automatic rail stops shall be placed on either side of opening of hydraulic hoists conveying iron to mixers.

(v) Guards shall be placed in front of truck wheels and an automatic alarm shall be installed on mixer iron transfer ladle.

(w) There shall be a signal system between mixer, pourer and operator of transfer ladle to notify operator when heat is poured and ladle is ready to move.

(x) The uncapping stand shall be equipped with sliding doors or railed off to such a distance as will allow the proper cooling of ingot before it can be uncapped.

VESSELS.

(y) A warning whistle shall be provided to give warning when vessel is to be tipped.

(z) Bells shall be placed under vessels, rung from scrapping floor to warn slag men that vessel is about to be scrapped; bell shall also be rung when scrapping is finished.

(aa) When new vessels are being installed, or when making repairs or replacements that would justify the cost, would recommend vertical outside packed plungers, thereby doing away with inside packing.

STEEL CRANES.

(bb) Safety catches or stops shall be placed on jibs of all steel cranes to prevent ladle running off the end of jib.

(cc) Steel cranes shall be equipped with automatic safety device that will hold crane jibs and ladle suspended over molds regardless of failure of pressure or any other cause.

LADLES.

(dd) All ladle trunnions shall be drilled and tested before being placed in service.

POURING PLATFORM.

(ee) We believe that a side lever for pouring steel is much safer for the men than pouring from straight in front of the ladles.

(ff) Pouring platform shall be amply large and provided with a number of exits to allow men to escape in case of accident.

(gg) All platforms for operators shall be so placed that operators can see the operation of their machinery at all times.

SECTION 4.

BLAST FURNACES.

(a) Each blast furnace shall be equipped with a telephone or speaking tube between the skip hoist operator's house and the blower's office. One shall also be installed near top of furnace for use of signalmen or men engaged in constructing or repairing top of furnace.

(b) Platforms, properly railed and with toe-boards, shall be installed at all elevated points where employes are required regularly to go to oil or for other purposes. Platforms shall be provided at the steam or air cylinders for the bells. All such platforms when exposed shall be roofed, to protect the men from slips. Permanent iron ladders or stairways shall lead to these platforms.

(c) Approved eyesights shall be installed on all tuyeres.

(d) The mud gun shall be equipped with a funnel-shaped casting over the receiving hole of the mud cylinder, also with shield to prevent hot metal burning the workmen.

(e) Platforms, properly railed, shall be provided for all explosion doors.

(f) Explosion doors shall be so built that nothing but gas and fine ore can escape from the furnace.

CAST HOUSE, ETC.

(g) **Casting Holes.**—Casting holes, where ladles are loaded under the floor, shall be grated or railed.

(h) **Cast Houses.**—Egress from cast houses shall be provided by runways or stairs of ample width at the ends of sides of each cast house.

The elevated floor of the cast house shall be properly railed.

(i) **Tapping Hole.**—A shield shall be provided, so designed and constructed that a hole no larger than that required for the movement of the drill is left open.

(j) **Cinder Notches.**—Cinder notches shall be provided with shields which can be used to protect men botting in the cinder notch.

(k) Gates in iron and cinder runners shall be operated from such a distance that men operating the gates will not be in danger of being burned.

(l) All gas washers and gas mains used in connection with gas washers, which may have to be cleaned, shall be provided with valves at each end of the system, by which they may be completely shut off so as to be safe from danger through explosion.

(m) **Bustle Pipe.**—All blast furnaces shall have a railed walk with toeboards on the bustle pipe, with stairs or stationary steel ladders leading to them.

(n) **Outrigging.**—The outrigging on all blast furnaces shall be equipped with a runway, with proper railing and toeboard.

(o) **Protection From Slips.**—A steel roof shall cover all points where men work around

a blast furnace. The sheeting on the sides of the cast houses shall come down far enough to prevent storm beating in or stock being thrown in by slips of other furnaces; and hoisting machinery, cranes, etc., near a blast furnace shall be roofed to protect men from falling material.

(p) A small house shall be provided on top of a furnace or runway by a furnace, to protect men from slips.

HOT BLAST STOVES.

(q) All stoves shall be connected by railed walks, built with solid bottom and guard plates at least twelve inches high.

BLOWING ENGINE HOUSE.

(r) To prevent mistake in distinguishing the sound of similar whistles, the number of the furnace from which the signal is blown shall be shown in the power house by a light visible to the engineer.

(s) Signal whistles in blowing engine room shall be blown by electric power, operated by switches in cast houses, and a telltale light shall be located at the switch to show when circuit is made.

STOCK YARDS AND STOCK BINS.

(t) Ore bridge trolley cabs shall be equipped with brakes, air whistles or gongs,

and with safety switches located on top of cab.

(u) Safety switches shall also be installed at each end of bridge between trucks, to cut off all power from each set of truck gears, respectively. Trucks must be provided with automatic brakes.

(v) In handling of stock from pockets, the bottoms of which are formed by drums, gates must be installed over the drums to prevent material falling on car operator.

(w) Pockets of any kind shall be shielded so as to prevent material dumped from above running through the pocket and injuring employes in the alley below.

(x) All scale cars and transfer cars shall be equipped with air brakes, fenders and continuously ringing gongs while the car is moving.

(y) The skip pit shall be so constructed that there will be ample clearance for a man on all sides of the skip car. All skip pits which cannot be entered at bottom level shall be equipped with stairs. Where openings are made in stock trestle to accommodate skip they shall be guarded.

(z) Skip car track shall have a shield on under side from the top of furnace, terminating in a chute near the base of the skip.

(aa) Bins used for flue dust must be provided with heavy cast iron knife edge sluice gates, adapted to cutting off hot dust.

(bb) Sprinkling arrangement shall be installed at all dust catchers, so as to wet the dust thoroughly as it is emptied into car.

(cc) Operating devices for dust catchers shall be provided which will enable employes to dump these at a sufficient distance to avoid possible burning by the hot dust. The down-legs shall be low enough to prevent scattering of the dust.

SECTION 5.

BOILER PLANTS APPROVED BY BOARD OF ENGINEERS.

A. Conformity with Local Ordinances.

The legal requirements of the community in which the boilers will operate are, of course, to be observed, as they are devised with safety provisions in view. If there is any direct conflict between such ordinances and the following suggestions, the ordinance will, of course, take precedence.

B. Factor of Safety.

Unless otherwise specified (for instance, by local ordinance), all parts of the boiler which are used under steam pressure shall be designed

with a factor of safety of not less than 5. By this it is to be understood that with a material which ruptures when a stress of 60,000 pounds per square inch is applied, the maximum stress to which this material is to be subjected when in service as a part of boiler, must not exceed 12,000 pounds per square inch.

C. Longitudinal Seams of Cylindrical Shells.

All longitudinal seams, steam and water drums should be butt strap joints of approved type, and so arranged that the gases will not be impinged upon them. Rolled steel flanged nozzle connections for steam outlets should be used. Where tube headers are used, as in some types of water tube boilers, they should be so designed that resistance to pressure on cap will not depend on the holding power of the cap bolt. All tubing should be of steel.

D. Rivet Holes in Plates.

All rivet holes shall be drilled with the sheets bolted in place; then the plates moved apart and the burr on the edge of the holes removed. In case the exigencies of the construction work require that a few holes be punched, they should be punched at least ¼ inch smaller than the size of the rivet and increased to full size by the use of a reamer. The proper making of rivet holes in boiler plates is regarded as

of special importance, and the purchaser should always reserve the right to have an inspector present while this work is being done.

E. Drum Heads.

The heads of cylindrical shells or drums should be pressed and not rolled or hammered.

F. Connections for Pipes.

One-inch or under pipe connections to boiler shells, except those for water columns (see paragraph V), may be connected to the shell plates by threads cut into the plate. All pipe connections larger than 1 inch should be by means of pressed or rolled steel flanges or annealed steel castings riveted to the plates, or by other approved means.

G. Manholes.

Manholes in tube or drum should be reinforced by steel rings, having a sectional area equal to that of the piece removed in forming the opening, measured on its longest axis.

H. Manhole Covers.

Manhole covers should be made of flanged steel or annealed cast steel.

I. Cast Iron.

No cast iron shall be used in any part of a boiler subject to pressure. If castings cannot be avoided they should be annealed steel.

J. Fastening Tubes.

In water tube boilers the tubes should be rolled and belled, extending not to exceed 3/8 inch into the water space. In fire tube boilers the tubes should be rolled and beaded.

K. Boiler Supports.

Boiler supports are to be made of structural steel in all cases where the boiler is not self-supporting on the foundation. The supports for water tube boilers should be independent of the brickwork of the setting, so far as the movements of either boiler or setting due to heating are concerned.

Where two horizontal water tube boilers are set together in one battery continuous girders should run over the boilers from one side of the battery to the other, from which the boilers are to be suspended. These girders should be strong enough to carry the boilers without vertical columns set in the division wall between the boilers. Cast iron brackets on boiler shells should not be used.

L. Stays for Boiler Setting.

The stays of the settings should not be located where they are subjected to a temperature of over 600° F. This result may be secured by observing the suggestions under paragraph K.

M. Dry Plates.

A dry plate should be placed in the drum under the steam nozzle of each boiler, attached by angle irons, riveted to the interior of the steam drum or boiler shell. This dry plate should extend about 3 feet on each side of the steam nozzle, and it should be about 8 inches from the top of the shell. Steam on its way to the steam nozzle passes around the ends of this dry plate. If dry pipes seem to be more suitable in certain types of boilers or under certain conditions they may be used instead of dry plates.

N. Steam Mains and Connections Thereto.

Steam headers receiving the steam from several boilers should be placed at a sufficient distance from the nozzles of the boilers to permit the use of "gooseneck" connections, capable of considerable expansion without introducing dangerous stresses on flanges or nozzles. A straight connection from the boiler nozzle to the steam header should be avoided. "Gooseneck" connections to the side of a header may be used, but the top connection (that is, vertical connection on header) is preferred. The bottom connection to a header is an objectionable construction, and should not be used. Where a

line reduces from one size to another, eccentric fittings should be used in order to bring the bottom of the different sizes of pipe to the same grade line, and thus avoid pockets.

O. Pipe Flanges.

(a) Pressed or rolled steel flanges are preferred, but cast steel may be used where the conditions make it seem advisable; and cast iron may also be used for moderate pressure and small sizes. Sections of pipe thus fitted should not be bolted in place until the companion faces of the flanges are machined true planes and parallel. Flanges should match properly without the necessity of springing the pipe into place. If the pipe section does not fit into the system properly, as a matter of safety to secure the necessary alteration of form fit the section and flanges to a prepared templet.

(b) It is not necessary to corrugate the faces of the flanges. Corrugated metallic gaskets have proved satisfactory, of steel, monel metal or copper, the preference being in the order named. Where there is water in the steam, asbestos gaskets or corrugated copper with asbestos between have not proven satisfactory. Under these conditions rubber will give better results than asbestos.

P. Gate Stop Valves.

A gate stop valve of approved construction should be set at the outer extremity of the "gooseneck" connection to the boiler, and as near the steam header as possible. In all cases the valve stem should have its threads outside of the valve casing.

Q. Non-return Valves.

Non-return valves of the triple-acting type are advised for all boilers, the same being set in the "gooseneck" connection of the boiler, as near to the nozzle as practicable. This valve should be provided with an effective cushioning device, to prevent hammering and destruction of seats when pressure on both sides of valve is nearly equal.

R. Drain Pipes.

Drain pipes should be connected to the several "goosenecks" just above both stop and non-return valves, to prevent pocketing of water when valve is shut, said drain pipes leading to receivers of traps for the automatic removal of water that may collect. The outlets from these drain pipes should be so placed in receivers or traps that water cannot return through these pipes. A check valve

should be set in each drain pipe, to prevent the backward flow of steam when the boiler is out of service.

S. Spring Loaded Pop Safety Valves.

(a) At least two spring loaded pop safety valves should be applied to each boiler by means of a separate steam nozzle having no connection or possible communication with any part of the steam system. The casing surrounding the safety valve spring must be locked in such a manner that only authorized persons may have access to the spring for inspection or adjustment. A testing lever should project through the casing, whereby the hand lifting of the valve from its seat is possible at the time of its periodic inspection.

(b) Each safety valve should be of sufficient capacity to discharge all the steam the boiler will produce when it is evaporating at the capacity at which the boiler normally operates.

(c) In purchasing safety valves the manufacturers should furnish reliable information as to the number of pounds of steam the valve will discharge per hour, as this varies widely among the different makes of valves of the same diameter.

(d) The springs of safety valves become gradually weaker with use. In order to make

a weakened spring continue to resist the pressure it must be more compressed, which reduces the pitch of the spring and the lift of the valve. Therefore a record should be kept of the lift of the valve at its rated capacity, and all valves gone over at least once per year, to be sure that approximately the original lift is still obtained.

(e) All safety valves on boilers in regular service should be tried at least once during each turn by easing them gently from their seats to insure the valve always being free to operate.

(f) Escape pipes from safety valves should be vertical and have an outlet through the roof of the boiler house wherever practicable. Horizontal escape pipes from safety valves are to be avoided in all cases, as they produce an undesirable and frequently severe thrust on the boiler nozzle when a violent escape of steam occurs.

(g) Drain pipes should attach to escape pipes from safety valves as near as possible to the safety valve. These drains should be open connections to ash pit or sewer.

T. Steam Pipe Expansion.

Systems of steam piping should be laid out with great care, in order to provide for expan-

sion and contraction. The expansion should preferably be taken care of by loops or bends, and if necessary by expansion joints. In all cases the **anchorage** of the piping is just as important as the loops or bends. The pipe systems should be anchored at certain points in such a way that these points will be absolutely fixed.

It is particularly necessary to see that this expansion does not throw any undue strain on any part of the piping system or on the steam chests of engine cylinders, etc., to which the pipes are connected.

U. Blow-off Pipes.

(a) When the blow-off branch pipes are so located as to be exposed to the hot products of combustion they should be protected by fire brick piers. A sufficient space for the inspection of all parts of the blow-off connection should be provided, and the contact of same with brickwork, flue dust or other moisture collecting material is to be avoided.

(b) Blow-off valves should be attached in pairs to each blow-off pipe; the valve next to the boiler being a gate valve or straightway cock; the one connecting the branch to the main blow-off line should be a regular boiler

blow-off valve. A short drain pipe attached to the portion of blow-off branch between these valves is suggested, but not imperative.

(c) Blow-off headers should be laid in a concrete trench with Y connections to the branches. Steel pipe should be used, and the pipe should be free to expand, to prevent excessive strain when it becomes heated.

(d) Blow-off headers should discharge into a hot well provided for the purpose, and not directly into a sewer. This hot well should be provided with a pipe at least ten feet high for the escape of vapors.

V. Gauge Glasses, Water Columns, Etc.

(a) Each boiler should be equipped with a water column and fittings in the manner hereafter described, and so located that a view of the gauge glass from the boiler room floor is not intercepted by stairways, platforms, etc. Where it is necessary to provide a special platform for the water tender, this platform should not interfere with a view of the gauge glass from a position on the boiler room floor, because it may be necessary to verify the water level from this point.

(b) The water columns should be of approved design, and each fitted with not less than three try-cocks, with angle cocks and

swivel guard of the revolving shield or wire netting type for the gauge glass. This gauge glass guard is to be capable of rotation around the glass as a safety precaution while work is being done upon the water columns, such as the insertion of new glasses, packing the same, etc.

(c) The try-cocks on the water columns are to be three in number, of the lever type exclusively, and connected by chains or rods to handles readily accessible from the boiler room floor and operating platform.

(d) No valves are to be permitted between the water column and the boiler, and the pipe connection of the water column to the boiler shell should be by means of steel flanges riveted to the shells, as tapped connections in boiler plates for the support of water columns are not sufficiently strong for the purpose intended.

(e) In steam and water connections to water columns no ells are to be used; crosses and plugs should be used, which will give ready access for internal cleaning of all parts of the water column system.

(f) Water columns in horizontal tubular boilers should be set so that the difference of level of the bottom try-cock and that of the level of the top row of tubes is not less than

3 inches. Gauge glasses should be so set that the lowest visible level of water in said glass will correspond to 1½-inch level of water over the tubes.

(g) Drain connections from the water columns should have an open end into the ash pit, and be of sufficient size to permit any foreign material that may enter the columns to be blown out.

(h) Metallic unions of the "Kewanee" type, obviating the use of any soft packing material, should be used.

(i) Pipe connections leading to the water columns should be covered.

(j) Each water column should be equipped with a high and low water alarm whistle.

W. Feed Pipes.

(a) Each boiler feed pipe should be fitted with the following valves:

(1) A stop valve near the main feed line if the boiler is one of a battery, or near the feed pump in case of an isolated boiler.

(2) A feed controlling or regulating valve of approved type. (See further recommendations regarding feed control.)

(3) A suitable form of check valve, closing with any backward movement of the water from the boiler.

(4) A suitable strong valve with rising stem between the check valve and the boiler.

(b) The feed pipe should deliver the water very considerably below the lowest water level of the boiler. The feed water should be discharged in such a place in the drum that it does not come in immediate contact with drum sheets exposed to high furnace temperature.

(c) A drain pipe should be provided between valve at main feed line and stop valve at boiler, to prevent building up water pressure, should the former valve leak when the boiler is out of service.

X. Feed Pumps.

(a) Each boiler plant consisting of more than one boiler should be provided with feed pumps in duplicate. If direct acting pumps are used these should preferably be of the outside packed plunger type. For a single boiler the feeding device may consist of one steam pump and one .steam injector, or of two steam injectors.

(b) Feed pumps should be so located with reference to the lowest level of water in feed

water heaters, that there will be sufficient head on the inlet valves of pumps at all times to overcome the frictional resistance of the valves, to provide the necessary velocity of flow to the pump and to overcome the vapor pressure due to the temperature of feed water in the pump chambers.

(c) Valves for feed pumps should be either metallic valves or a type of hard rubber or fibre, capable of withstanding disintegration under the high temperatures which will exist.

(d) Where economizers are used the feed pipe system should be protected by a relief valve, possibly assisted by an air chamber, to protect economizers and feed piping from excessive pressure or shocks.

(e) It is advisable to equip the feed pumps with governors which will maintain a pressure in the feed pipe a **constant** number of pounds above the steam pressure. These pump governors are known as "Constant Excess Governors."

(f) Where it is at all possible there should be two sources of water supply to feed water pumps. In many plants this is possible by connecting up with a city water line, or by connecting to the regular service system of the works when the heater is ordinarily sup-

plied with hot well water by an independent pump.

Y. Feed Water Heaters.

(a) The overflow pipe and the steam escape pipe should be of ample size, and so located that they will always be free and unobstructed.

(b) If a balanced valve is ever used in the steam escape pipe to divert part of the steam to a heating system its use should be attended with the greatest care, and only by an experienced engineer. Under these conditions it is advisable to have the heater equipped with a mercury column or, preferably, a low pressure recording gauge, so that the pressure maintained in the heater by the balanced valve will always be known.

(c) Every effort should be made to prevent lubricating oil entering boilers with feed water. Especial care should be used in plants with surface condensers, cooling towers and return tubular boilers.

Z. Feed Water Regulators.

(a) The use of feed water regulators is recommended wherever they will be of advantage or assistance to the water tender in maintaining the water level. Their use is not suggested for the purpose of fuel economy or to effect labor saving by dispensing with water

tenders, but only for the purpose of supplementing the work of the water tender, to relieve him of the detail of valve manipulation, thus enabling him to give closer supervision to the maintenance of the proper water level in all boilers.

(b) Wherever water regulators are used they should preferably be accompanied by the use of governors on the boiler feed pumps, the Constant Excess Governor mentioned above being preferred.

AA. Damper Regulators.

Where damper regulators and non-return valves are both used, great care must be exercised in locating the steam connection of the regulator to the main steam system. If this steam connection is made in the main steam system, and a break occurs in this system, the steam pressure will fall, closing the non-return valves and also opening the damper regulator, thus putting full draft on boilers with the main valves closed. To avoid this, the connection for the damper regulators should be made to several boilers between non-return valves and boilers.

BB. Steam Gauges.

(a) Each boiler should have its own steam gauge, attached by means of a syphon of suf-

ficient capacity to insure the gauge tubes being kept full of water.

(b) At least one recording gauge should be connected to each steam system, so that should an accident occur there will always be available a record of the steam pressure at that time.

(c) All steam gauges should be kept in good condition, so that the pressure indicated will be approximately correct. For testing gauges a weight testing machine should be used, and such a machine should be available for the use of each Works where boilers are operated.

CC. Settings of Boilers.

(a) Settings of boilers should be constructed with full consideration of the requirements in paragraph K on supports, so that the boiler structure is independent of the brickwork, so far as possible.

(b) Paragraph L, referring to stays for settings, should be kept in view when designing new settings.

(c) It is particularly important in the case of boilers having large bottom drums, such as those of the Stirling type, to keep the brickwork around the windows at the ends of those drums entirely free from contact with the

metal surface. Those windows should be closed by a separate tight fitting cast iron door, attached to a circular casting, which is properly fitted into the brickwork.

(d) Communicating with the last pass in gas fired boilers, it is advisable to have one or more explosion doors fitted into the wall of the setting, the seats of which doors should be set at an angle at which the gravity closure of the doors is obtainable, while they are at the same time free to open in case of excessive pressure developing in the setting.

(e) Boiler fronts should always be bolted to the settings in such a way that they will not become loose or fall down when the brickwork is removed.

DD. Platforms, Stairways and Lighting.

(a) A system of walks or runways should be erected to give convenient access to overhead valves, water columns, etc., also walks from boiler to boiler, and suitable platforms at individual valves, from which they can be safely operated or repaired.

(b) Walks and platforms should be well lighted and free from breaks or obstructions which might interfere with their use.

(c) They should be equipped with hand rails not less than 36 inches high, with two hori-

zontal members, and with toeguards not less than four inches high.

(d) Walks and stairways should be of suitable steel construction, checkered steel plate or grids being used for flooring except in the vicinity of water columns, where it may be advisable always to have the gridiron construction, in order to provide a clear view of the water column from the boiler room floor, as previously recommended.

(e) Wherever possible railed stairways are to be used in preference to ladders. Where practicable, stairways should be substituted for existing ladders.

(f) Means of access should be provided for overhead walks at both ends of each line of boilers, and in large plants one or two intermediate stairways are desirable.

(g) It is very desirable to have red incandescent lamps suspended near important cut-off valves or branches from steam mains or headers, to facilitate readily locating same in case of emergency.

(h) A protected light, preferably an incandescent lamp, should be suspended near each water column.

(i) Special attention should be given to securing good illumination throughout the boiler house. Unless the illumination is ex-

ceptionally good, it is advisable to have at least one light at each of the stairways leading to overhead platforms, particularly at the upper end of the main stairways.

EE. Numbering Boilers.

(a) Each boiler should be fitted with at least three number plates (each having the same number), as follows:

(b) One on the front of the boiler; one on the rear of the boiler; one on the pipe system between the boiler steam nozzle and the header, in such a position that it can be readily seen from the walk or platform on the top of the boiler setting.

(c) These plates may be enameled, with the figures of a different color, or heavy sheet metal with perforated figures.

FF. Stokers, Coal and Ash Handling Machinery.

(a) All gearing for stokers, coal and ash handling machinery, etc., should be as completely covered as possible by substantial cast iron or sheet metal covers, so designed as to be readily detachable.

(b) All couplings, set screws, keys, bolts, etc., in moving parts must be covered or countersunk in such a way as to eliminate danger of accident. Unused portions of keyways should be filled, so as to present a smooth surface.

SECTION 6.
CHARGING CARS.

(a) Charging cars shall be equipped with guards over the truck wheels, covering both the front and the sides of the wheels.

(b) Warning gongs shall be placed on all cars.

(c) All gears shall be encased, and a plate guard shall extend along both sides of the traversing carriage runway, of sufficient height (at least three inches) to prevent men placing their feet on the track.

(d) Bumpers shall be placed on each traversing carriage track, to prevent the carriage running back closer than two inches to the end plate.

SECTION 7.
COLLARS AND SET SCREWS.

(a) Collars used on shafting shall have safety flanges high enough so that the head of the set screws will not project above the flange.

(b) All set screws shall be placed in safety collars, countersunk or covered by a guard.

SECTION 8.
COUNTERWEIGHTS.

All counterweights shall be so situated or guarded that they cannot fall on someone, should something break.

SECTION 9.

ELECTRIC TRAVELING CRANES—APPROVED BY BOARD OF ENGINEERS.

A. General Construction.

(a) Proper provisions should be made for all parts subject to impact and rough usage. Journals and shafts shall be of sufficient size to bring pressure and deflections within safe and practical limits.

Structural work should be of O. H. steel, and physical and chemical properties shall be governed by the Manufacturer's Standard Specifications for medium steel.

All apparatus should be designed throughout with not less than the following factors of safety under static full load stresses, based on ultimate strength of material used.

Gears, drums, blocks, hooks, shafts and other parts except ropes, and girders subjected to dynamic stresses, ten (10).

Ropes, not less than eight (8). (See American Steel and Wire Company's Catalogue for ultimate strength of rope.)

Crane girders, not less than five (5).

For cranes handling hot metal and other extra hazardous service the factor of safety

given above for hoisting rope should be increased at least 25 per cent.

Calculations for wind pressure on outside cranes should be based on not less than thirty pounds per square foot of exposed surface.

(b) No cast iron should be used, except for drums, bearing caps, collector shoes, trolley collector hinges, arm and collector supports, steel being employed in preference to cast iron in all other parts. Cast gear covers may be malleable iron. No wood or other combustible material to be used in the construction of any crane.

(c) All bolts should be through type, no studs or cap screws being used unless by special agreement; bolts to be suitably secured from turning, and equipped with approved lock nuts or lock washers.

(d) All track wheels should preferably be rolled steel, .70 or .80 carbon, O. H. steel. Where special conditions make it desirable they may be cast iron or cast steel centers with rolled steel tires shrunk on. They should be accurately finished for diameter and tread required. Tread shall be of sufficient thickness to carry rated load when wheels have been reduced 1¼-inch in diameter.

Flanges should not be less than one (1) inch thick by ⅞-inch deep, not including fillet at

tread. The face of doubled flanged track wheels shall be ¾ inch more than the width of the head of the rail.

Wheels should be keyed to their shafts, and gears keyed to hub of wheels. Wheels and axles should be so designed that not too much of the total load will come on one bearing.

No wheel of less than the following diameters shall be used:

Bridge wheels on cranes under five tons capacity, eighteen (18) inches.

Bridge wheels on cranes over five tons capacity, twenty-four (24) inches.

Trolley wheels, twelve (12) inches.

The maximum load on any one wheel with trolley fully loaded shall not exceed 70,000 pounds. Where conditions are such as to cause the frequent application of this load this wheel load shall be decreased if practicable.

(e) Rails are to be fastened to girders by clamps "as required," so arranged that the bolts can be conveniently replaced if necessary; suitable stops must be riveted to girders to prevent creeping of rails.

(f) Steps or stairs with hand rails are to be used wherever possible, in preference to ladders.

B. Footwalks.

(a) Footwalks should be placed in the following locations:

Entire length of bridge on both sides.

Across both ends of trolley at right angles to bridge walks, but they must not telescope over end carriage.

(b) Footwalks shall be of substantial construction, rigidly braced so as to eliminate vibration, and built entirely of steel.

Width of main walks, not less than 30 inches from outer edge of walk to web of girder.

Width of trolley walks, not less than 15 inches.

(c) Wherever possible all walks should be so arranged that there will be a clearance of at least six feet six inches between floor of walk and overhead trusses or other structural members; clearance between railing on bridge walk and nearest part of trolley to be not less than 18 inches.

(d) Footwalk should pass underneath and around, instead of over bridge motor, and may be reduced to a width of 15 inches (clear) at point where it passes motor.

(e) Each walk shall have a standard railing and toe guard at all exposed edges.

Railings to be of riveted structural steel or pipe construction, with two horizontal mem-

bers, and not less than three feet six inches high; toeguard to be at least six inches (net) in height.

Floors of walk should be of checkered steel plate, not less than ¼-inch thick; flooring must extend from outside toeguard to bridge girder, and be fitted neatly where any irregularities occur, so as to leave no openings through floor.

C. Operator's Cage.

(a) Operator's cage must be securely fastened to bridge girders, and well braced, to minimize vibration. It should be large enough to allow ample room for equipment and operator.

For 3-motor cranes, cage should not be less than 6 feet by 7 feet 6 inches.

For 4-motor cranes, cage should not be less than 6 feet 6 inches by 8 feet.

For 5-motor cranes, cage should not be less than 7 feet by 8 feet.

(b) Floors to be of ¾-inch impregnated asbestos board, or concrete, 3 inches thick, on steel plate not less than ¼ inch thick.

(c) Cage should be enclosed to a height of 3 feet 6 inches above floor with sheet steel or woven steel mesh; if not so enclosed standard toeguard, not less than 6 inches (net) in height, must be placed around exposed edges.

(d) A safe and convenient arrangement shall be made to allow operator to pass from cage to footwalks and bridge girders; where a ladder is used, it should preferably be inside cage, but in every case the arrangement must be such that there will be no danger of operator falling to ground when using it.

(e) Floor of cage shall be extended on entrance side so as to form a landing not less than 15 inches wide; this landing to be equipped with handrail and toeguard, of same construction as bridge walk.

Note.—Where there is a fixed platform at top of stairway or ladder that will serve the same purpose, this landing may be omitted unless it is needed to comply with provisions of paragraph C (d).

(f) An approved foot or hand operated gong shall be placed in a convenient location and securely fastened, to eliminate danger of parts working loose and falling.

(g) Ladle and other cranes subjected to heat from below must have ⅛-inch sheet steel shield, six inches below bottom of floor, to insulate floor from heat.

D. Shafting, Couplings, Gears, Etc.

(a) All parts of crane must be readily accessible, and so designed that it will not be

necessary to remove any keyed part, or disturb any other shaft in order to change any shaft on the crane.

(b) All hoisting shafting, carrying gears, pinions, drums or sheaves to be of rolled or forged open hearth steel, the net required section being increased in diameter by not less than twice the depth of keyseat.

(c) All connections subject to torsion are to be pressed or shrunk on and keyed in place. Press fits to be made with pressure of not less than ten (10) tons per inch diameter.

(d) Unless of type known as safety flange, couplings shall be entirely enclosed, the covers being so designed that they are readily detachable, and supported in such a manner that they do not revolve with the shaft.

(e) No overhung gears, except armature pinions, and no split gears shall be used.

(f) All gears shall be completely covered or guarded by cases or covers firmly and substantially attached to brackets or other part of crane, of sufficient clearance to prevent their being struck by any of the enclosed parts, and, wherever practicable, they shall be oil tight. Covers shall be in two pieces, split horizontally, and so fastened and arranged that top half can be removed for inspection and repairs without disturbing the bottom half. Directly above

the mesh line of teeth there shall be a hand hole with cover held closed by spring hinge. Gear covers may be cast, but should preferably be sheet steel, not less than ⅛ inch thick.

(g) Keys to be secured in approved manner to prevent possibility of gears working loose; unprotected keys must not be left projecting from ends of shafts; they must be covered or otherwise protected.

(h) All bearings except those on motors and those of the M. C. B. type shall have approved screw feed compression grease cups; these cups to be made accessible to footwalks, and provided with extension pipes where necessary to bring them within easy reach of walks.

E. Switchboard and Wiring, Etc.

(a) The installation of switchboard, wiring and all electrical equipment must fully comply with the requirements of the National Board of Fire Underwriters.

(b) Wiring, switchboard and other electrical apparatus should preferably be in accordance with the Carnegie Steel Company Rules and Requirements for the Installation of Electrical Wiring and Apparatus.

(c) Switchboard should be placed in rear of cage, and contain the following equipment:

Two pilot lights.

One D. P. main line switch.

One D. P. magnetically operated circuit breaker, with an individual overhead relay and fuse for each motor on crane; circuit breaker to be so designed that it will open automatically if current supply fails, and remain open until closed by operator.

(d) Switchboard and its equipment to be enclosed in asbestos lined steel cabinet, with swinging door arranged so that it can be latched.

(e) There should be a main line switch, in addition to the one on crane switchboard, mounted above cage where it can be conveniently reached from footwalk; this switch must be so constructed that it can be locked in open position.

(f) All wiring must be placed in approved conduits, which should be continuous to switch boxes, etc., so that there are no bare terminals exposed.

(g) Trolley conductors should preferably be soft steel bars or other suitable rolled steel sections,—with tinned joints and good mechanical supports. They should preferably be located outside and above bridge girder, on side opposite bridge motor, in convenient relation to footwalk; in no case shall their location be

such that they may be brought into accidental contact with hoist cable.

(h) Open type controllers to have asbestos lined steel guard over the movable contact parts.

(i) Rheostats and resistance units to be protected from accidental contact or mechanical injury, by suitable enclosure, adequate provision being made for ventilation.

F. Brakes.

(a) Each crane hoist should preferably be equipped with an approved system of dynamic braking.

(b) Brakes complying with the following requirements should be supplied:

a. Mechanical retaining brake.

b. Electrodynamic braking control.

c. Series-solenoid operated brake on commutator end extension of armature shaft.

d. Auxiliary (of safety) solenoid operated brake, located on shaft as close as practicable to drum.

e. Foot brake shall be provided which, with 125 pounds pressure on foot lever, shall stop crane within a distance in feet equal to 10 per cent of full load speed in feet per minute when traveling at full speed with full load. This brake to be arranged to be conveniently fastened in "on" position.

All brake supports, except for "d," shall be attached to lower half of motor frame or motor, and brake shall be mounted on one common cast base, "as required."

Each brake shall be capable of retarding full load at double speed, and holding same when stopped, unaided by other brakes.

Brake wheels shall be web form, finished all over and perfectly balanced. Face of wheel shall be double flanged to center the brake strap where same is used.

Brake shoes or strap shall have sufficient clearance when "off" to prevent dragging on the wheel.

Brakes for same size motors shall be duplicates, except for the omission of solenoid on brake "e."

D. C. solenoid shall be single spool, preferably floating core type, with coil wound on heavy cast spool, and protected from the weather by metal casing. Winding shall be of fireproof insulated wire or strap, which in the case of series coils shall have cross section not less than that of the motor fields with which they are in series, but no wire larger than No. 2 B. & S. gauge shall be used.

A. C. coils shall be single phase, have fireproof insulation throughout, and be held rigidly in cores.

Means shall be provided to prevent the various parts of solenoids or brakes from falling, in case they become loose.

Mechanical retaining brake shall be screw friction type of liberal area, simple in design, so as to necessitate minimum attention, and of sufficient capacity to absolutely prevent load from lowering unless motor is revolved by power in the lowering direction.

When electro-dynamic brake is specified, lowering speed of armature shall be limited to twice the normal full load speed of armature with full load on hook.

G. Hoist Limits.

(a) An approved normally closed limit device should be provided for each hoist; this must be tripped directly from hoisting block or hook, and **not** through screw contacts.

(b) Dynamic braking must be employed in connection with hoist limit to check speed of motor.

H. Hoist Mechanism.

(a) All hoists should be equipped with approved steel cable, no chain being used. Special flexible hoisting rope of extra strong crucible cast steel or plow steel or monitor plow steel shall be used, either brand having six (6) strands, thirty-seven (37) wires to the strand. Hemp cord may be used for ordinary

service, but core must be of soft iron where subjected to excessive heat.

(b) The pitch diameter of hoist drums and sheaves should be at least thirty times the diameter of the cables. The drums must have flanges at each end, not less than 1 inch thick, projecting at least 2½ inches from body of drum.

(c) Drums to be so designed that there will be not less than two full wraps of hoisting cable in the grooves when hook is at lowest position called for in specifications.

(d) Hook block shall be of an approved type, so arranged that it will lift vertically without twisting; hooks to be of solid forged steel or laminated, built up of steel plates.

(e) Bottom sheaves must be protected by close fitting guards, to prevent rope from becoming misplaced, also to prevent foreign objects from falling into block.

I. Bumpers and Wheel Guards.

(a) Substantial bumpers, with springs, wood blocks or other approved form of cushioning device, shall be provided at end of trolley travel; these bumpers must be securely attached to bridge girder or to runway rails.

(b) Bumpers of compression spring type shall be at least five (5) inches in diameter

at point of contact, and so arranged that in case of breakage of spring or guide pin, no part can fall from crane.

(c) Substantial fenders or plate guards extending to below top of rail, and projecting in front of all bridge and trolley track wheels, shall be rigidly attached to carriage or end frame. They shall be of a shape and form that will tend to push and raise a man's hand, arm or leg off rail and away from wheel.

Note.—Arrangement for necessary clearance between fenders and end bumpers or stops should be provided.

J. Miscellaneous.

(a) Heavy safety lugs or brackets shall be placed on trolley frames and end carriages, to limit drop to one inch or less if a wheel or axle should break.

(b) Trucks should be provided with adequate pads for use with jacks or wedges when changing track wheels; cranes to be designed so as to permit changing wheels by simply relieving the bearings of the weight.

(c) For the protection of workmen underneath, a pan made of not less than 3/16 inch steel plate, with openings for ropes and with

toeguard around edges and openings, shall extend underneath the entire trolley.

(d) A plate showing the rated capacity of each hoist in pounds shall be placed on each girder in such a manner as to be clearly legible from the floor.

(e) Provision should be made for sand boxes, controlled from cab.

(f) Not less than four (4) inches actual clearance shall be allowed between highest point of crane and roof chord, and not less than three (3) inches between any other part of crane and building column or other stationary structure.

For cranes in outside service the following additional provision should be made:

Floors of footwalks to be so constructed as to drain through openings of floor.

Cage should be enclosed and of fireproof construction. There should be metallic sash windows on three sides of cage; windows in front and side opposite door to be full width of cage.

Where there are no members over crane suitable for attaching blocks, a structural steel outrigger should extend across bridge girders, of sufficient strength to lift heaviest part of trolley. Outrigger to be located over bridge motor.

K. Cranes, Gantry.

(a) Wherever practicable, the foregoing shall be considered as Gantry crane specifications.

(b) All Gantry cranes shall be equipped with automatic warning bells.

(c) The truck wheels of Gantry cranes shall be provided with guards or fenders.

L. Cranes, Locomotive.

(a) All locomotive cranes shall be provided with an iron guard at the end of the boom, through which the cable may run, small enough to prevent the thimble on the cable coming in contact with the sheave wheel.

(b) Water gauge glasses shall be provided with guards.

(c) Locomotive cranes shall be equipped with automatic couplers placed on an extension, where necessary, so that there will be sufficient clearance between the end of the boiler and the car being coupled to.

(d) All locomotive cranes shall be equipped with outriggers and rail clamps.

(e) The truck bed shall be equipped with a hinged guard, which, when extended, will prevent any one being caught between boiler and the truck bed.

(f) All new cranes shall have a clearance of at least 18 inches between the bottom of the boiler and the truck frame.

(g) Locomotive cranes shall be equipped with indicating pointers showing safe load at any angle of the boom.

M. Drops and Skull Crackers.

(a) All drops and drop testing machines and skull crackers shall be enclosed with material of sufficient strength to stop flying pieces. "Danger—Keep Out" signs shall be at all openings.

(b) The opening between the hoist house and the drop shall be guarded by bars and screens, to protect the engineer. The rope used to release the ball shall lead outside the drop.

N. Electrical Work.

The installation of electrical equipment shall be in accordance with the requirements of the National Board of Fire Underwriters and comply with the Carnegie Steel Company's rules and requirements for the installation of electrical wiring and apparatus.

SECTION 10.

ELEVATORS.

(a) All legal requirements, such as local building codes, city ordinances, etc., should be observed, and if there is any direct conflict

between these specifications and such legislation, the latter should, of course, take precedence.

(b) Material and workmanship must be first-class in every respect. All elevator equipment shall be designed with the following factors of safety, based on the ultimate strength of the material used, when under full load stresses:

Parts subject to dynamic strains, such as gears, gear shafts, drum shafts, etc., not less than ten (10).

Lifting and counterweight cables, not less than eight (8).

Other parts, such as cage framing, etc., subject to static strains, not less than five (5).

(c) Elevator equipment shall be of metal or other approved non-combustible material throughout, with the exception of cage floor, which may be of hard wood not less than 3 inches in thickness.

(d) There shall be at least two lifting and two counterweight cables each; they shall be of standard iron or crucible steel hoisting rope, 6 strands, 19 wires to the strand. Sheave diameter to be not less than forty times the diameter of rope. Hand line to be of tiller rope, "6 x6x7" construction; sheave diameter for tiller

rope must be at least twenty-seven times that of the rope.

(e) Both lifting and counterweight cables of a drum machine elevator shall have at least two full turns of cable on the drum when the car is at the lowest and highest points of travel.

(f) Sheaves of operating rope must be thoroughly guarded, so that the rope cannot be misplaced.

(g) An approved device shall be provided for lock or securing the starting rope in the cage, so that the elevator cannot be started from any other point.

(h) Wherever practicable, a "centering rope" shall be installed, arranged so that it can be given a direct pull to center the operating arrangement and stop the elevator.

(i) All gearing shall be **completely enclosed** with substantial cast iron or sheet steel covers, so designed as to be readily detachable; these covers to be oil tight wherever practicable. All couplings, set screws, keys, bolts, etc., in moving parts, shall be countersunk or covered in such a way as to eliminate danger of accident; unused portion of keyways to be filled so as to present a smooth surface.

(j) Gears, pinions and parts subjected to excessive wear or strain shall be of steel, phos-

phor bronze, etc., cast iron being used only in places where strength is of minor importance.

(k) Unused sides of cage must be enclosed to a height of 6 feet from the floor. This enclosure may be of woven steel fabric, No. 9 wire, 1 inch mesh, where it is desirable for the operator to see through the enclosure; otherwise sheet steel (not less than No. 14 gauge), shall be used.

(l) Elevator cage shall be provided with substantial cover, to prevent danger of tools or material falling on persons in the cage, from overhead.

(m) Where an elevator serves two stories or more, it shall be equipped with an approved speed governor.

(n) All elevators except those of hydraulic plunger type shall have an approved type of safety clamp, which will engage the guides and stop the car in case the hoisting cables should break or become detached. This clamp must be thrown into engagement by a spring or mechanical device, and not by gravity; it must be arranged, however, so that the gripping power of the clamp is not obtained from a spring.

(o) Hydraulic elevators shall have suitable provision to prevent plunger being forced out of cylinder in case of accident to controlling mechanism.

(p) Where electric power is used, the installation of controlling apparatus, wiring, etc., shall comply fully with the requirements of the National Board of Fire Underwriters. All apparatus carrying electric current must be thoroughly insulated, enclosed or guarded in such a manner that there will be no danger of accidental contact with live parts. Wiring shall be placed in approved conduits, which shall be continuous to switch or fuse boxes, etc., so that there are no bare terminals exposed. Main line switch must be provided with an approved locking device.

(q) A standard sign reading, "Capacity of This Elevator Is —— Pounds; Do Not Overload It," shall be permanently displayed in each elevator cage.

(r) Doors or gates must be placed at all entrances, and where operator is regularly employed doors shall be arranged so that they can be opened only from within. If gates are used, they should be preferably of the semi-automatic type, but they may be manipulated entirely by the operator, if necessary, and full automatic gates may be used at upper and lower floors.

(s) Gates shall be 6 feet in height, wherever possible, to prevent anyone looking over top of them; if this height is impracticable, suitable

means shall be provided to prevent accidents from descending cage (such as tell-tale chains, suspended from bottom of cage).

(t) Where the elevator cage passes close by beams, floors, etc., they should be beveled off and sheeted over, to prevent possibility of a foot being crushed between them and the floor of cage.

(u) Platform with railing and toeboards shall be placed at top sheaves, for use of oilers, repairmen, etc., with permanent ladders to these platforms, where necessary. Toeboards must be at least 4 inches high, railings not less than 36 inches, with two horizontal members.

(v) A pit at least 3 feet 6 inches in depth must be provided at lower floor, and an equal clearance allowed between overhead platform or beams and top of cage, when it is at upper floor level.

(w) Bumpers shall be placed at bottom of elevator pit with suitable spring or oil cushioning device. They may be located at floor level for hydraulic plunger elevators, but must not be less than 12 inches below floor level for other types. These bumpers should be of such length as will insure a minimum clearance of at least 2 feet 6 inches between bottom of cage and pit floor, to prevent danger of anyone being crushed by the descending cage.

(x) Additional counterweight bumpers shall be provided, on which the counterweights will come to rest, when the car is 2 feet 6 inches below overhead beams or platform at top of shaft.

(y) Checkered steel plates, or other safety tread, shall be placed at each elevator entrance to prevent slipping.

(z) Means for disconnection of power, independent of the ordinary controlling arrangements, shall be provided for each elevator, to be used when making inspections, repairs, etc. This may consist of a gate valve for hydraulic and steam elevators, a switch for electric elevators, and a tight and loose pulley or friction clutch for belt driven elevators. In each case a lock and chain shall be provided, to be placed on this disconnecting device when it is being used for anyone's protection.

(aa) A suitable electric or mechanical signaling gong shall be provided for each elevator, so arranged that it can be rung from any floor served.

(bb) All counterweights shall have their sections securely bolted together, and they shall be so situated that they cannot fall on any part of the elevator or machinery. There shall not be less than 2 feet 6 inches clearance between top of counterweight and under side of over-

head beams, when the car is resting on the bottom bumpers.

(cc) Counterweight slides shall be guarded where there is danger of some one having a hand caught between the weight and framing. A door or other suitable provision shall be made, to allow for convenient inspection of counterweight cables.

(dd) Two stop buttons shall be placed on operating rope at both top and bottom positions, separated about ¼ inch, so that if one slipped the other would stop the car. These should be located so that they only come into play after the car has gone a few inches beyond its normal stopping position, so that the operator will not depend upon them for his ordinary stops. They are for emergency service only. The stop motion device on engine or motor driven elevators shall be arranged to operate at terminal floor levels.

(ee) Standard sign reading, "Danger; Do Not Ride on Elevator; Use Stairway," shall be posted in a conspicuous location at each freight elevator.

(ff) Where elevators are driven by electricity, the controller board, motor and starting mechanism, etc., shall be placed in such a location that they are not liable to be obstructed by stock, or tampered with. Where they are

in a common room of warehouses, storehouses, etc., they shall be partitioned off or enclosed with woven steel fabric, No. 9 wire, 1 inch mesh, or other suitable non-combustible material. A door with lock should be provided for entrance to this enclosure. All wiring should be placed in approved metal conduit. Conduit and metal enclosures of switchboards, etc., to be suitably grounded.

SECTION 11.
EMERY WHEELS.

(a) All grinding wheels, except shaped and those used for special grinding, shall have a safety taper of at least three-eighths of an inch to the foot on each side, and shall be equipped with safety collars. Where it is practicable, all wheels shall be of the safety type.

(b) All grinding wheels, standard or special shapes, shall be guarded where practicable with a boiler plate hood of sufficient thickness to retain the wheel, should it explode. This is in addition to safety collars.

(c) Where dry grinding is done, some protection for the eyes shall be provided.

SECTION 12.
EMBANKMENTS AND EXCAVATIONS.

(a) All embankments, runways, platforms, etc., over five feet high, and those of less height which are dangerous, shall be railed.

(b) All excavations that are liable to cave in shall be shored up. These excavations shall be protected by barriers, and at night by lights.

SECTION 13.

STEAM ENGINES.

(a) The governor, if not of the shaft or flywheel type, should be driven with ropes not less than three in number.

(b) The governor sheaves should have suitable guards of substantial construction; sheaves to be keyed to shaft, and unused portions of keyway filled so as to present a smooth surface.

(c) Where fly ball governor is used and it is near a footwalk platform or ladder the revolving parts should be properly guarded or enclosed.

(d) Set screws in all moving parts should be countersunk or placed in safety collars.

(e) Where main bearings cannot be readily reached from the floor they should be equipped with steps, properly railed; railings to have two parallel members and an approved safety tread to be used for the steps.

(f) All platforms and walks on engine should have railings and toeguards. All places where an oiler walks on the engine should be railed. This applies also to the engine bed

where it is subjected to use as a footwalk alongside of the connecting rod or cross-head. Toeguards should be at least 4 inches high, and railing not less than 36 inches high with two horizontal members. Where pipe is used for railings it should be standard or full weight, and no railings should be made of pipe smaller than 1½ inch, inside diameter.

(g) Stationary iron ladders or stairways must be provided for access to emergency valves which cannot be reached from the floor or other safe place.

(h) An approved guard or enclosure should be provided along connecting rod and crank, and also at tail rod, unless oil shields are so arranged as to thoroughly enclose and safeguard these points without further protection.

(i) Fly wheels should be guarded by either plate or suitable wire fencing. Where the protection is within 18 inches of the wheel it should be 5 feet high; where it is more than 18 inches from the wheel it should be 3 feet 6 inches high, and at the ends the distances should be measured from the periphery of the wheel. The guards should be carried over the bearings at the same relative height. The outside guard on the stairs over the bearings may be made of bare railings. Wheels less than 5 feet above the floor line where the protection is

less than 18 inches from the wheel should be entirely encased.

(j) A relief valve should be placed in each end of each cylinder, and these valves should have means for testing to make sure that they are always in working order.

(k) Care should be taken in regard to the design of valve mechanism and other moving parts to avoid places where a hand or foot might be caught and crushed. Where such places necessarily occur they should be properly safeguarded.

(l) No live steam connections should be made to a receiver without a reducing valve set so that the pressure it will permit shall be well within the safe working pressure of the receiver and the low pressure cylinder.

(m) Each receiver should be equipped with one or more safety relief valves of ample capacity, and set to blow at a pressure well within the safe working pressure of the receiver and low pressure cylinder. These valves also should have means for testing, to make sure that they are always in working order.

(n) It is recommended that engines be equipped with automatic engine stops. Speed limits should be used in connection with these automatic stops, and means should be provided for shutting down engines from various safe

points. A system of regular inspection and testing of these automatic stops and speed limits should be devised at each Works to suit local conditions. Where engines are shut down frequently, as at the end of each turn, a good means of testing the automatic stop is to use it in shutting down the engine. If electrically actuated automatic stops are used, the wiring system should be on a closed circuit. Wires should be placed in conduits if possible and should be looped so that each circuit can be tested separately and so that in case of a break in one line no other line will be put out of service. If current for operating the solenoid stop mechanism is always available an auxiliary battery is not necessary, except to insure continuous operation of the engines. The storage type of battery is the most reliable.

(o) Condensing engines should be provided with means for breaking vacuum at the same time that the automatic engine stop shuts off the steam. Where other engines are on the same condenser a quick closing valve on the exhaust should be provided, and in such cases vacuum breakers would not be required.

(p) Jet condensers should be provided with a float operated vacuum breaker to open when the water rises to a certain level in the con-

denser, in order to prevent water getting into the engine cylinders.

(q) The accumulation of oil and dirt on fly wheel and in fly wheel pits should be prevented, and the wheels and pits cleaned at intervals, to avoid danger from fire, which may easily occur if oil, grease and dirt be allowed to collect.

(r) Steam traps used to discharge the water from steam separators should be so placed that it will be known that they are operating. If it is necessary to locate these traps below the engine room floor or any place where their operation cannot be seen, an electric light or some other signal device, such as a bell, should be used to indicate when the trap discharges. Accidents are liable to occur if traps are not kept in good working order.

(s) In taking the cylinder heads off engines the indicator cocks should first be opened to make sure that there is no steam pressure in the cylinder. In addition to this the joints between the head and the flange should be broken before all the nuts on the cylinder bolts are completely unscrewed. This will prevent the head being blown off when the joint is broken, should any pressure exist in the cylinder.

(t) Before entering an engine cylinder the man should close all throttle valves and lock same and take the key with him and place a warning sign, and break vacuum or close connection to condenser; or, where there is no other sure means of preventing the starting of the engine, the fly wheel or crosshead should be locked so that they cannot move.

(u) It is advised that each company have a blank printed, which may be called "Engine Inspection Report," or otherwise designated. The purpose of this blank is to afford a convenient and easy method of keeping a record of inspection of engines, and to provide a permanent record of the condition of each part of an engine, which will always be available for reference in case of accident. The form of report and the time of inspection of each engine should be arranged by the management.

SECTION 14.

EXHAUST PIPES.

(a) All exhaust pipes within seven feet of the ground, or in such a position as to endanger a passerby, shall lead into exhaust pits, which pits shall be covered with metal covers.

(b) All exhaust lines to condensers shall be provided with a free exhaust, adjusted to open automatically and by hand line.

(c) Provide for condensation in receiver and exhaust pipes.

SECTION 15.

FOUNDRIES.

(a) A locking device shall be provided for the brass cupola. When heavy with skull it will tip over if not locked.

(b) All hoisting chains on rings shall be of equal length.

SECTION 16.

GAS PRODUCERS.

(a) Provision shall be made so that when a producer is shut off from the main pipe, or when a soaking pit or a furnace is cut out, the gas cannot accidentally be turned on again.

(b) Cleaning doors on gas pipes opening on a platform or walk shall be so constructed that they can be locked shut to prevent a back pressure of gas forcing them open.

(c) All cleaning doors or explosion doors on gas pipes or mains shall be hinged. Where there are counterweights on explosion doors, they shall be provided with safety chains or other devices, to prevent the weight or door falling, should something break.

(d) Bar hole stoppers shall be put on with hinges.

SECTION 17.

GEARS AND SPROCKETS.

(a) All gears shall be completely enclosed.

(b) All sprockets shall be thoroughly guarded.

SECTION 18.

GUARD RAILS AT BUILDINGS.

A guard rail shall be placed at the doorways or corners of buildings near railroad tracks, to prevent a person suddenly stepping on the track.

SECTION 19.

HOOKS.

(a) Hot metal cranes shall be equipped with laminated plate hooks, containing several thicknesses of plate riveted together.

(b) Hooks shall be designed amply strong, with a factor of safety which will render them safe under any load which may possibly be carried by the crane.

SECTION 20.

KEYS IN SHAFTING.

(a) All projecting keys in shafting, where exposed to contact, shall be cut off or guarded.

(Note.)—See "Shafting."

SECTION 21.

LADDERS.

(a) Ladders shall be made of steel and shall be stationary, and the rungs shall be at least eight inches from the wall or column to give proper foothold. No pipes or other material shall be allowed back of a ladder closer than eight inches to the ladder. Where practicable, a ladder shall not be longer than 20 feet without a break and platform. WHEREVER POSSIBLE, STAIRS SHALL BE PROVIDED INSTEAD OF LADDERS.

(b) All portable ladders, where practicable, shall be equipped with metal points or spurs at the bottom and with hooks at the top.

SECTION 22.

LADLES.

(a) All ladle cars shall be equipped with some device for keeping ladles in an upright position.

(b) All ladles must be bottom heavy, so as to assume an upright position in case of breakage of any part of dumping mechanism.

SECTION 23.

LEVERS.

(a) All levers and switches controlling the movements of machinery shall be so con-

structed that they can be locked, to prevent starting the machinery.

(b) A cotter pin or lock nut shall be placed on all operating levers, to guard against the possibility of the lever coming off.

SECTION 24.

MANHOLES, PIT COVERS AND TRAP DOORS.

Manholes and pit covers shall be so constructed that at least three sides of the hole will be guarded when cover is raised.

SECTION 25.

MILLS.

(a) Subways or viaducts shall be provided where passageway across the mill is required. Subways shall be roofed with plate, to prevent scale from the tables falling into them. Table shafting which can be reached from subway or stairs shall be encased.

(b) Drive shafting on roller tables shall be covered with hinged plate covers over the top of shafts, and with hinged aprons at the side, or entirely encased.

(c) All coupling boxes, pinions and wabblers shall be guarded with shields.

(d) Leading spindles shall be fenced, if not otherwise guarded.

(e) Where passageway over spindles is required, viaducts shall be provided.

(f) Platforms shall be placed on roll and shear housings, six feet or higher above the floor, with a ladder leading to same.

(g) Walks running parallel with crane runways shall be placed on buildings wherever practicable.

(h) Safety switches shall be installed in turntable pits, so that men going into the pit can cut all power off from the table.

(i) Bumpers shall be placed at the dead end of all roller tables to prevent material over-riding the end of the table.

(j) A steel arm shall be placed at the outside ends of the skids of all loading beds, to prevent material from falling from the bed.

(k) Scale tunnels under mills shall be arranged, where practicable, so that it will not be necessary for men to go under table when removing scale. This should be overcome by conveyors, or by making the pit on an incline, so that the scale will slide to one side.

SECTION 26.

OPEN HEARTH.

(a) When rebuilding a furnace a tight plank fence shall be built on the charging floor,

to prevent material falling on men working in the furnace ports.

(b) The hydraulic jib cranes shall be provided with a cable running over the sheave at the inner end of the boom and attached to the floor at the base of the crane, to draw the runner back from over men working at the tapping hole.

(c) Provision shall be made so that when a furnace is down for repairs the gas cannot accidentally be turned into the furnace.

(d) Provision shall be made on hot metal cranes, so that no man can be confined in any crane cage, or in any other place where it would be impossible for him to escape to some place of safety, in case of a spill of hot metal.

SECTION 27.

PLATFORMS.

(a) Platforms five feet or more above the ground shall be railed and equipped with a stairway or stationary steel ladder.

(b) Platforms and walks ten feet or more above the ground shall have a toeboard at the base of the railing, at least six inches high.

(c) Operating platforms or floors must be equipped with checker plates, woven steel fabric, rivet heads or other approved non-slipping surface.

(d) All high machines of any sort must be provided with suitable platforms and ladders, if necessary for men to oil or work around the top.

SECTION 28.

RAILINGS.

Note.—Each Works shall adopt standard hand rail designs, and not deviate from their designs except when absolutely necessary.

(a) Railings shall be at least three feet six inches high, with an intermediate rail of equal distance between top rail and floor. All railings shall be made of metal, and when ten feet or more above the floor shall have a toeboard at least six inches high at the base of same. Angle posts shall be chamfered.

(b) Pipe railings shall be made of not less than 1¼-inch pipe. Angle railing shall be made of not less than 2x2x¼-inch angle iron.

SECTION 29.

RUNWAYS.

(a) All runways used for wheelbarrows or walks shall be at least twenty-four inches wide, with cleats nailed on the under side. They shall be properly braced to avoid the danger of spreading and teetering; they shall also have cleats on the top at the sides, to give the men toehold and prevent them from slipping.

(b) All runways ten feet or more above the ground shall be provided with a railing, with a toeboard at the base of same.

(c) Runways shall form a part of original construction, and not be left to the field to provide safe access to valves, etc., in elevated positions.

SECTION 30.

RAILROAD.

(a) All cars on narrow gauge or broad gauge tracks shall be provided with either automatic M. C. B. standard or automatic link and pin couplings.

(b) All special railroad cars for skelp steel, open hearth charging boxes, etc., shall be provided with suitable side stakes or end stakes.

(c) All important railroad crossings shall be provided with swinging railroad gates. If necessary, provide light on same at night.

(d) All dead end tracks shall be provided with approved bumping blocks.

(e) All very dangerous places shall be provided with overhead bridges or subways, to keep men off the tracks entirely.

(f) The design and application of all safety devices shall be in strict accordance with the National and State Railway Safety Appliance Laws.

(g) All frogs, switches and guard rails shall be blocked.

(h) When new switch stands are installed they shall be constructed so that the ball will be thrown parallel with the rails.

SECTION 31.

SAWS.

All saws, circular or band, high or low speed, shall be provided with approved shields.

SECTION 32.

SEWERS.

Sewers for steam or hot water shall not be covered with planking only; use metal, brick or cement.

SECTION 33.

SHAFTING.

(a) Drive shafting on roller tables shall be covered with hinged metal covers over the top of shafts, and with hinged aprons at the side.

(b) Shafting within twelve inches of the floor shall be encased.

(c) Shafting higher than twelve inches and not more than seven feet from the floor shall be railed off or otherwise guarded.

(d) The ends of shafting, where exposed to contact, shall be protected.

(e) Shafting overhead, to be oiled while running, shall be equipped with walks for the use of oilers.

(f) Shaft couplings shall be enclosed.

(g) The shaft shall extend at least the diameter of the shaft outside the hub of the gear or pulley, so that provision can be made for locking the key.

SECTION 34.

SKYLIGHTS.

Skylights shall be constructed so as to eliminate all danger from falling glass; if possible, building shall be designed without skylights.

SECTION 35.

SLINGS.

All slings used on hoists shall, where practicable, be made of wire cable, instead of chain, as cable gives warning of weakening by broken strands.

SECTION 36.

SMOKESTACKS.

Smokestacks shall be equipped with stairs or ladders, equipped with safety cages. The treads of ladders shall not be attached to the stack,

but shall be attached to side pieces, which shall be so anchored to the stack at regular intervals.

SECTION 37.

STAIRS.

Stairs shall not be built at a sharper angle than 50 degrees. Over 50 degrees, ladders shall be used instead. Note the following table of risers and treads. The sum of the riser and tread shall equal about 17½ inches.

Angle with Horizontal.	Riser, Inches.	Tread, Inches.
27.33	6	11½
29.03	6¼	11¼
30.35	6½	11
32.08	6¾	10¾
33.41	7	10½
35.16	7¼	10¼
36.52	7½	10
38.29	7¾	9¾
40.06	8	9½
41.44	8¼	9¼
43.22	8½	9
45.00	8¾	8¾
46.38	9	8½
48.16	9¼	8¼
49.54	9½	8

SECTION 38.

STEAM LINES.

(Note)—See "Boilers." (Section No. 5.)

(a) All permanent small steam lines, when placed underground, shall be boxed in so that leaks will not cut away the earth, making a pocket into which someone might step.

(b) High pressure steam lines shall not be run through offices unless thoroughly protected against breakage.

SECTION 39.

TRAVERSING CARRIAGES OF MACHINES.

The traversing carriage of any machine, engine or lathe shall not be allowed to run out within a distance of eighteen inches from any fixed structure not being a part of the machine, if the space over which it runs is space over which any person is liable to pass, whether in the course of his employment or otherwise.

SECTION 40.

TRESTLES.

(a) Trestles shall be equipped with walks, the outer edge of which shall be at least six feet from the rail. Where practicable, the floor

of this walk shall extend to within four inches of the ends of the ties. Each walk shall be equipped with a substantial metal railing and toeboard.

(b) Where there is a driveway or passageway under a trestle, it shall be completely planked over at that point, between the rails and between the tracks.

(c) Bents or trestle supports shall be enclosed, forming division walls, keeping iron from tangling around legs of open bents supporting trestle. (Do not advocate division walls except where trestle supports are located.)

(d) On trestles over pig iron yards and other places where material is unloaded from side of cars, footwalk can be placed at a distance, and part of floor of walk can be arranged so that it can be lifted to allow metal or other material to fall through.

SECTION 41.

VALVES.

(a) Platforms, stairs or stationary steel ladders shall be provided, by which to reach emergency valves higher than an ordinary man.

(b) A cotter pin or lock nut shall be placed at the ends of all valve stems, to prevent the

wheel slipping off the shaft, and important valves shall be marked for identification.

(c) Levers and chains operating gas and steam valves shall be provided with a locking device.

SECTION 42.

WINDOWS.

Safe means shall be provided for cleaning windows or skylights. Properly equipped cages, running on track or runways, railed and with toeboards, are suggested. These installations must safeguard the men against crane travel or other moving machinery.

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